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METHOD AND APPARATUS FOR OVERCOMING LARGE TRANSPORT DELAYS BETWEEN MASTER AND SLAVE UTOPIA DEVICES

TECHNICAL FIELD OF THE INVENTION

This invention relates generally to computer and telecommunications networks and more particularly to a method and apparatus for overcoming large transport delays
5   between master and slave UTOPIA devices.

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BACKGROUND OF THE INVENTION

Manufacturers of network equipment encounter increasingly complex data transfer design issues as networks and network devices have evolved into sophisticated systems. An increasing number of network systems now utilize asynchronous transfer mode (ATM) technology, which in many applications provides a more effective way to transfer data across a network.

ATM is a layered architecture allowing multiple services like voice, data, and video to be mixed over the network. Three lower level layers have been defined to implement the features of ATM. An Adaptation Layer assures the appropriate service characteristics and divides all types of data into a 48 byte payload that will make up an ATM cell. An ATM Layer takes the data to be sent and adds a 5 byte header information that assures the cell is sent to the right connection. A Physical Layer defines the electrical characteristics in network interfaces. This layer performs necessary operations to effect transmission of data along the transmission media. However, ATM is not tied to a specific type of physical transport.

A number of protocols exist for transmission of information between the ATM Layer and the Physical layer. One such protocol is the Universal Tests and Operation Physical Interface for ATM (UTOPIA) data path interface. UTOPIA defines the interface between the Physical Layer and upper layer modules such as the ATM Layer. The definition allows a common physical interface in ATM sub-systems across a wide range of speeds and media types. UTOPIA controllers are physical devices that implement the UTOPIA protocol for transmitting information between the physical layer and the ATM layer. A UTOPIA I controller is capable

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of controlling a single slave device, a UTOPIA II controller is capable of controlling a plurality of slave devices, and a UTOPIA III controller is capable of controlling an even larger number of slave devices.

5   UTOPIA protocol is often used to transfer data between an ATM card and a line card. Often the DSL line card will be physically located at a significant distance from the ATM card. Communicating data from the ATM card to the DSL line card directly over a cable according to UTOPIA

10   specifications is not currently implemented because of the large transport delays that would be associated with transmitting timing signals and data over a large-length cable. Therefore, current implementations utilize two UTOPIA devices located between the ATM card and the line

15   card to effect such transfer.

These devices consists of a physical device located on the ATM card acting as a UTOPIA slave and a master UTOPIA controller. Data is transferred between the ATM card and the slave physical device according to UTOPIA protocol, and

20   data is transferred from the master UTOPIA controller to the DSL line card according to UTOPIA protocol. However, data is transferred between the slave UTOPIA physical device and the master UTOPIA controller according to any suitable format, and typically in serial format.

25   Such an implementation for data communication between an ATM card and a physical device, such as a DSL line card, is expensive and consumes more resources than needed.

SUMMARY OF THE INVENTION

Accordingly, a need has arisen for a method and apparatus for overcoming large transport delays between master and slave UTOPIA devices. The present invention

5 provides a method apparatus that addresses shortcomings of prior systems and methods.

According to one embodiment of the invention, a system for communicating information includes a master UTOPIA device having a receive transfer controller operable to

10 control reception of data by the master UTOPIA device and a transmit transfer controller operable to control transmission of data from the ATM switch. The system also includes a slave UTOPIA device having at least one memory area. The slave UTOPIA device includes a receive poll

15 controller operable to determine whether the memory area is available to transmit data for receipt by the master UTOPIA device and further operable to communicate the result of the determination to the receive transfer controller. The slave UTOPIA device also includes a transmit poll

20 controller operable to determine whether the memory area is available for receiving data to be transmitted by the master UTOPIA device and further operable to communicate the result of the determination to the transmit transfer controller.

25 According to another embodiment of the invention, a method for communicating information between master and slave UTOPIA devices includes providing a master UTOPIA device having a receive transfer controller operable to control reception of data by the master UTOPIA device and

30 a transmit transfer controller operable to control transmission of or from the master UTOPIA device. The method also includes providing a slave UTOPIA device having

a receive poll controller operable to determine whether the slave utopia device is available to transmit data and further operable to communicate the result of the determination to the receive transfer controller and a

5   transmit poll controller operable to determine whether the slave UTOPIA device is available for receiving data and further operable to communicate the result of determination through the transmit transfer controller. The method further includes connecting the master UTOPIA device to the

10   slave UTOPIA device and transmitting information between the master UTOPIA device and the slave UTOPIA device. The step of transmitting includes determining, by the receive poll controller located on the slave UTOPIA device that the slave UTOPIA device is ready to transfer data to the master

15   UTOPIA device, and in response initiating, by the receive transfer controller located on the master UTOPIA device, transfer of data from the slave UTOPIA device to the master UTOPIA device and determining, by the transfer poll controller located on the slave UTOPIA device, that the

20   slave UTOPIA device is ready to receive data to be transmitted by the master UTOPIA device, and in response initiating, by the transmit transfer controller located on the master UTOPIA device, transfer of data from the master UTOPIA device to the slave UTOPIA device.

25   Some embodiments of the invention provide numerous technical advantages. For example, some embodiments of the invention allow communication of the data between a master UTOPIA device, such as an ATM card, and a slave UTOPIA device, such as a DSL card, over a medium having

30   significant length without the adverse effects typically associated with direct communications between the two devices. Furthermore, such data communication may be

effected without the use of intervening UTOPIA physical slave device and a master UTOPIA controller, thereby decreasing the costs of implementing certain communications systems, such as DSL. According to another embodiment, the

5   amount of memory used on the line card is reduced because no intermediate storage is required on the line card.

Other technical advantages are readily apparent to one skilled in the art from the following figures, descriptions, and claims.

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BRIEF DESCRIPTION OF THE DRAWINGS

For a more complete understanding of the present invention and the advantages thereof, reference is now made to the following descriptions taken in connection with the accompanying drawings in which:

FIGURE 1 is a block diagram of a communications system showing conventional components utilized to transfer data between a master UTOPIA device and a slave UTOPIA device;

FIGURE 2 is a block diagram of a communications system for transferring data from a master UTOPIA device to a slave UTOPIA device according to the teachings of the present invention;

FIGURE 3 is a block diagram of the communications system of FIGURE 2 showing additional details of the system, including ports for receiving data and instruction signals as well as the associated signals;

FIGURE 4 is a flowchart illustrating a method for receiving data at the master UTOPIA device illustrated in FIGURE 2 and 3 from the slave UTOPIA device shown in FIGURE 2 and 3;

FIGURES 5 is a flowchart showing method for transmitting data from the master UTOPIA device shown in FIGURES 2 and 3 to the slave UTOPIA device shown in FIGURE 2 and 3; and

FIGURE 6 is a block diagram showing an alternative embodiment of a communications system for transferring data between a master UTOPIA and a slave UTOPIA device, showing additional parallel/serial converters for allowing more rapid transfer of data between the master and slave devices.

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DETAILED DESCRIPTION OF THE INVENTION

Embodiments of the present invention and its advantages are best understood by referring to FIGURES 1 through 6 of the drawings, like numerals being used for
5   like and corresponding parts of the various drawings.

FIGURE 1 is a block diagram of a communications system 10. Communications system 10 allows communication of data between the ATM layer and the physical layer in asynchronous transfer mode communications. As illustrated,
10 communications system 10 includes an ATM card 11 and a line card 17. ATM card includes an ATM switch 12 and a physical device 14, each described in greater detail below. Line card 17 includes a DSL interface 18 and a master UTOPIA controller 16, each described in greater detail below. ATM
15 switch 12 implements the functions of the ATM layer specified by ATM specifications. These functions include adding a five-byte header that assures a cell is sent to the correct connection. Relevant ATM specifications include Utopia 3 Physical Layer Specification af-phy-
20 0136.000, November 1999; Utopia Level 2 af-phy-0039.000, June 1995; and Utopia af-phy-0017.000, March 1994, and may be found at, for example, ATMFORUM, which is incorporated herein by reference. In this example, ATM switch 12 acts as a master UTOPIA device because, as described below, it
25 controls data transfer with it according to UTOPIA specifications. DSL interface 18 implements the physical layer functions specified by the above-referenced ATM specification. DSL interface 18 performs necessary operations to effect transmission of data along a
30 subsequent transmission media (not explicitly shown). DSL interface 18 may be designed to implement various types of physical layers, including DSL, Gigabit Ethernet, and

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SONET.   In this example, DSL interface 18 acts as a slave
UTOPIA device because, as described below, data transfer
with it is controlled by a master UTOPIA device.
Communication with ATM switch 12 and with DSL interface 18

5   occurs according to the Universal Tests and Operation
Physical Interface for ATM (UTOPIA).   UTOPIA defines the
interface between ATM switch 12 and physical device 14
between master UTOPIA controller 16 and DSL interface 18.
UTOPIA includes various forms, which currently include

10   UTOPIA I, UTOPIA II and UTOPIA III, described above.

In order to transfer data between ATM switch 12 and
DSL interface 18 according to UTOPIA specifications,
conventional implementations utilize a physical slave
device 14 and a master UTOPIA controller 16 disposed

15   between ATM switch 12 and DSL interface 18.   These devices
14 and 16 act as an intermediary for data transfer between
ATM switch 12 and DSL interface 18.   Physical device 14
operates as a slave UTOPIA device and communicates with ATM
switch 12 under the control of ATM switch 12, as described

20   below.   Master UTOPIA controller 16 acts as a master UTOPIA
controller and communicates with DSL interface 18 according
to UTOPIA specifications over line 24 under the control of
master UTOPIA controller 16.   Therefore, ATM switch 12 and
physical device 14 communicate with each other according to

25   UTOPIA specifications, and master UTOPIA controller 16 and
DSL interface 18 communicate with each other according to
UTOPIA specifications.   Once data is transferred to either
physical slave device 14 or master UTOPIA controller 16,
data may then be transferred between device 14 and 16 over

30   cable 22 according to any suitable format, and not
necessarily UTOPIA.   Cable 22 may be a suitable media for

transmitting data between ATM switch 12 and line card 18. One example of cable 22 is a backplane.

Transfer delays conventionally have hindered utilization of UTOPIA protocol for transferring data over a large distance because of the timing requirements associated with UTOPIA protocol are inconsistent with large transport delays, which are normally associated with transfer of data over a large distance. Because of this problem, physical device 14 and master UTOPIA controller 16 have conventionally been used to effect transfer between a master UTOPIA device 12, such as an ATM switch and a DSL interface 18, such as a DSL card, when the two devices are located a large distance from each other. The invention recognizes alternative methods for directly transferring data between ATM switch 12 and DSL interface 18 that do not require the superfluous use of physical device 14 and master UTOPIA controller 16. Such methods may be best described by first providing a description of certain components within ATM switch 12 relevant to its operation as a UTOPIA controller.

Conventionally, ATM switch 12 includes a UTOPIA controller 28 and is capable of controlling a slave device, such as physical slave device 14. If UTOPIA II protocol is utilized, a UTOPIA II controller located on ATM switch 12 may control a plurality of devices 14. If UTOPIA III protocol is utilized, a UTOPIA III controller on ATM switch 12 controls a plurality of devices 14, and also allows transmission of data in 32 bits (as opposed to 16 for UTOPIA I and UTOPIA II).

UTOPIA controller 28 includes a receive UTOPIA controller 30 and a transmit UTOPIA controller 32. Receive UTOPIA controller 30 includes a poll controller 34 and a

transfer controller 36. Transmit UTOPIA controller 32 includes a poll controller 38 and a transfer controller 40. The receive poll controller 34 transmits an address 42 corresponding to a physical device from which data is to be

5 received. In response, the physical device, such as, in this example, physical device 14, returns a cell available indication 44, to receive poll controller 34. In an analogous manner, transmit poll controller 38 transmits an address 48 corresponding to a particular physical device,

10 such as device 14 and in response receives a cell available indication, as indicated by 50. In this manner, data is transferred from a master UTOPIA device, such as ATM switch 12, to a slave UTOPIA device, such as physical device 14.

15 According to the teachings of the invention, poll controllers are located remotely from the UTOPIA controller on a UTOPIA slave device to allow communication between the UTOPIA master and the UTOPIA slave device, without the use of devices 14 and 16 while overcoming large transport

20 delays that would otherwise occur. Except where otherwise indicated, hereinafter in this document, master UTOPIA device refers to a device that includes a transfer controller for controlling transfer of data with the master UTOPIA device and a slave UTOPIA device refers to a device

25 that is controlled in such a manner by the master UTOPIA device and that also includes poll controllers. This is in contrast to conventional usage that refers to master UTOPIA devices that include both transfer controllers and poll controllers and slave UTOPIA devices that do not include

30 poll controllers. Embodiments of the invention are described in greater detail in conjunction with FIGURES 2 through 6.

FIGURE 2 is a block diagram illustrating a UTOPIA communications system 110. UTOPIA communications system 110 includes an ATM card 111 having an ATM switch and also includes a line card 114. ATM card 111 may include other

5   components not relevant to the present invention. ATM switch 112 is one example of a master UTOPIA device, and line card 114 is one example of a slave UTOPIA device. Other master and slave UTOPIA devices may be utilized without departing from the scope of the present invention.

10   ATM switch 112 and line card 114 are similar to ATM switch 12 and line card 14, except as described below. ATM switch 112 communicates with line card 114 using UTOPIA protocol over cable 122. ATM switch 112 and line card 114 may communicate directly over cable 122, without intervening

15   devices, such as physical slave device 14 even if cable 122 has a significant length that heretofore would have prevented direct communication between ATM switch 112 and line card 114 according to UTOPIA specifications.

According to the teachings of the invention, poll

20   controllers 144 and 146 are located on line card 114, as opposed to locating these poll controllers on ATM switch 112. This allows ATM switch 112 and line card 114 to be located a considerable distance from each other, yet communicate directly. Otherwise, locating ATM switch 112

25   a considerable distance from line card 114 would result in unacceptable timing delays associated with ATM switch 112 polling devices on line card 114.

ATM switch 112 includes a transfer controller system 128 for controlling reception of data from line card 114

30   and transmission of data to line card 114. Transfer controller system 128 includes a receive transfer controller 136 and a transmit transfer controller 140.

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Receive transfer controller 136 controls reception of data by ATM switch 112. Transmit transfer controller controls transmission of data from ATM switch 112 to line card 114.

5   Line card 114 includes a poll control system 142 and a plurality of DSL modems 126. Poll control system 142 controls polling of devices on line card 114, such as a DSL modem 126. Poll control system 142 includes a receive poll controller 144 and a transmit poll controller 146. Receive poll controller 144 controls polling of DSL modems 126 to

10   determine whether DSL modem 126 is prepared to transfer data from line card 114 over cable 122 for receipt by ATM switch 112. Transmit poll controller 146 polls DSL modem 126 to determine whether DSL modem 126 is ready to receive data transferred by ATM switch 112. Poll controllers 144

15   and 146 are, in one embodiment, devoid of any memory areas, resulting in lower cost implementation.

DSL modems 126 perform manipulations on data received from ATM switch 12 necessary to transmit data along a digital subscriber line (DSL) and, conversely, perform

20   manipulations on data it receives for transfer to ATM switch 112. DSL modems 126 include a receive UTOPIA port assembly 148 and a transmit UTOPIA port assembly 150. Receive poll controller 144 communicates with receive UTOPIA port assembly 148 on DSL modems 126 over bus 130.

25   Transmit poll controller 146 communicates with transmit UTOPIA port assembly 150 on DSL modems 126 over bus 132. Additional details of UTOPIA communications system 110 and its operation are described in conjunction with FIGURE 3.

FIGURE 3 is a block diagram of communication system

30   110 showing additional details of the system. As illustrated, receive transfer controller 136 includes a plurality of ports associated with communication according

to UTOPIA protocol. Those ports are identified below according to conventional UTOPIA name and by reference numeral. The ports include a start of cell port 152 (SOC), a data port 154, a return clock port 156 (RTCLK), a clock

5   signal port 158 (CLK), an address port 60 (ADDR), a poll enable port 162 (POLL ENABLE), a serial cell available port 164 (SERIAL CLAV), and a start of serial cell available port 166 (SOCLAV). These ports receive and transmit information as described below.

10   Start of cell port 152 receives an indication that data is about to be transmitted. Data port 154 receives data transferred from line card 114. Return clock port 156 receives a clock signal returned from poll controller 144 that aligns incoming data. Clock port 158 provides a clock

15   signal to DSL modem 126 to control timing of transfer of data from DSL modem 126 to ATM switch 112. Address port 160 provides the address of a particular DSL modem 126 that will provide data for receipt by ATM switch 112. Poll enable port 162 provides an indication that polling of DSL

20   modems 126 should begin or stop. Serial cell available port 164 receives serial cell available information for each DSL modem 126. Start of serial cell available port 166 receives an indication from receive poll controller 144 that serial cell available information transmitted to port

25   164 is about to be initiated.

Transmit transfer controller 140 includes the same type of ports as receive transfer controller 136, as identified here: a start of cell port 168, a data port 170, a return clock port 172, a clock signal port 174, an

30   address port 176, a poll enable port 178, a serial cell available port 180, and a start of cell available port 182.

The ports on transmit transfer controller 140 function

in a similar manner as those on receive transfer controller 136 with the following differences: start of cell port 168 and data port 170 provide, rather than receive, respective signals, as compared to receive transfer controller 136.

5   Receive poll controller 144 on line card 114 also includes a number of ports for receiving and transmitting information. Those ports are identified here as: a poll enable port 184 (POLL ENABLE), a serial cell available port 186 (SERIAL CLAV), a start of serial cell available port 188 (SOCLAV), a cell available port 190 (CLAV), an address port 192 (ADDR), a clock port 193 (CLK), and a return clock port 194 (RTNCLK).

      Transmit poll controller 146 includes the same types of ports and are identified as follows: a poll enable port 196, a serial cell available port 198, a start of serial cell available port 200, a cell available port 202, a clockport 203, an address port 204, and a return clock port 206.

      Poll enable port 184 on receive poll controller 144 receives an indication from receive transfer controller 136 that polling should begin. Serial cell available port 186 provides serial cell available information for each of DSL modems 126 to receive transfer controller 136. Start of cell available port 188 provides to receive transfer controller 136 an indication that serial cell available port 186 is about to transfer serial cell available information for DSL modems 126. Cell available port 190 receives an indication from DSL modem 126 that it is available to receive data. Address port 192 provides an address location identifying a particular one of the devices 148 from which data will be received by ATM switch 12. Address port 192 also receives an address from address

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port 160, which may be used to verify that a particular one
of devices 148 is ready to transfer data. Clock port 193
receives a clock signal from transfer controller 136.
Return clock port 194 provides a return clock signal to
5   receive transfer controller 136 to control timing of
reception of data by ATM switch 112 from line card 114.

The ports on transmit port controller 146, described
above, provide or receive analogous information as the
respective ports describe above in conjunction with receive
10   poll controller 144.

As illustrated, each of DSL modems 126 includes a
receive port assembly 148 and a transmit port assembly
150. Receive port assembly 148 operates to provide data
for receipt by ATM switch 112 under the control of receive
15   transfer controller 136 on ATM switch 112. Transmit port
assembly 150 operates to receive data transmitted by ATM
switch 112 under the control of transmit transfer
controller 140. The ports associated with each port
assembly are described below.

20   Receive port assembly 148 includes a start of cell
port 210 (SOC), a data port 212 (DATA), a cell available
port 214 (CLAV), a clock port 216 (CLK), and an address
port 218 (ADDR). Start of cell port 210 provides an
indication that data is about to be transmitted to receive
25   transfer controller 136 on ATM switch 112. Data port 212
provides data for transfer from receive port assembly 148
to ATM switch 12 through receive transfer controller 136.
Cell available port 214 provides an indication to receive
poll controller 144 that device 126 is prepared to transmit
30   data for receipt by ATM switch 112. Clock port 216
receives a clock signal to control timing of polls and
resulting signaling and data transfer. Address port 218

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receives the address of the particular DSL modem 126 that
will provide the data for receipt by ATM switch 112.

Transmit port assembly 150 includes similar ports with
the following differences: A start of cell port 230 and a
5   data port 232 each receive their respective signals rather
than provide their respective signals, as is the case with
analogous ports on receive port assembly 148.

As described above, communications system 110 operates
to allow communication of data between ATM switch 112 and
10   UTOPIA devices such as modems.   Accordingly, two modes of
operation exist.   In a receive mode, ATM switch 112
receives data from DSL modems 126.   In a transmit mode, ATM
switch 112 transmits data from ATM switch 112 to DSL modems
126.   Each of these modes is described separately below in
15   conjunction with FIGURES 4 and 5.

FIGURE 4 is a flowchart illustrating a method for
receiving data at ATM switch 112 that is transferred by
line card 114.   The method begins at step 300.   At a step
302 receive transfer controller 136 expresses a desire to
20   have DSL modems 126 polled to determine whether a
particular device is ready to transmit data for receipt by
ATM switch 112.   To do so, receive transfer controller 136
outputs from poll enable port 162 a signal 259 for receipt
by poll enable port 184 on receive poll controller 144.
25   Signal 259 is set to "1," indicating polling should begin.
At a step 304, receive poll controller 144 polls all DSL
modems 126   and accumulates cell available signals 280
provided by cell available ports 214 of receive port
assembly 148.   In response, at step 306 receive poll
30   controller 144 outputs from serial cell available port 186
a signal 260 that includes a serialized version of the cell
available status for each DSL modem 126.   Signal 260

therefore provides to receive transfer controller 136 at serial cell available port 164 an indication of which devices are available to transmit data for receipt by ATM switch 12.

5   As part of step 306 of transmitting the serial cell available information from receive poll controller 144 to receive transfer controller 136, a start of serial cell available signal 262 is provided from start of cell available port 188 to start of cell available port 166

10   along signal 262. Signal 262 therefore provides an indication that a serial cell available signal 260 is about to be transmitted.

       At step 308, when receive transfer controller 136 receives on serial cell available port 164 signal 260

15   indicating that a DSL modem 126 is available to transmit data for reception by ATM switch 112, receive transfer controller 136 transmits from poll enable port 162 a poll enable signal 259 having a value of "0." Such a signal received by receive poll controller 144 at poll enable port

20   184 halts polling of DSL modems 126. This allows subsequent transfer of cells.

       At step 310 receive transfer controller 136 initiates data transfer for reception by ATM switch 112 by outputting the address of a selected available DSL modem 126 that is

25   ready to transfer data. This step is performed by outputting signal 258 for receipt by address port 218 on receive port assembly 148. Clock signal 256, which is provided by clock port 158, controls timing of transfer of data between line card 114 and ATM switch 112.

30   In response to step 310, receive port assembly 148 associated with the specified address signal 258 transmits data according to UTOPIA specifications at step 312. In

this regard, start of cell port 210 on receive port assembly 148 outputs signal 250 for receipt by start of cell port 152 on receive transfer controller 128. Signal 250 indicates the beginning of a data transfer. A data

5   port 212 on receive port assembly 148 also transmit data as data signal 252 for receipt by data port 154 on receive transfer controller 136, thereby effecting data transfer from line card 114 to ATM switch 112. Return clock port 194 outputs a return clock signal 254 for receipt by return

10   clock port 156 for aligning receipt of data signal 252 and clock signal 256. Return clock signal 254 is generated based on clock 256 and is returned to return clock port 156 to control timing of data receipt. Delay associated by generating return clock signal 254 at return clock port 194

15   on line card 114 data signal 252, which originated from line card 114, may be appropriately aligned by return clock signal 254. Once transmission begins, the method continues with step 302 in which a signal 259 is reset to 1 to enable continued polling of all devices 126. This polling may

20   occur while data are transferred.

In the above-described manner, data is transferred from a UTOPIA device, such as line card 114 and received by ATM switch 112. According to the teachings of the invention, such transfer may occur over a significant

25   length cable 122 while overcoming significant transport delay.

FIGURE 5 is a flowchart illustrating a method of ATM switch 112 transferring data to DSL modems 126. Many of the steps associated with transferring data to DSL modems

30   are analogous to the corresponding steps associated with receiving data at ATM switch 112. The method begins at step 400. At a step 402, transmit transfer controller 140

on ATM switch 112 output on poll enable port 178 signal 274 equal to "1." Signal 274 is received by poll enable port 196 on transmit poll controller 146. Setting signal 274 equal to "1" instructs transmit poll controller 146 to poll

5   all devices 126. At a step 404, transmit poll controller 146 polls all physical devices. In doing so, transmit poll controller 146 receives cell available signals 282 from cell available ports 234. Signal 282 indicates, for each device 126, whether the device is available to receive data

10   transmitted by ATM switch 112.

Transmit poll controller 146 receives the cell available information and converts it into a serial cell available signal, which is transmitted at serial cell available port 198 for receipt at serial cell available

15   port 180 on transmit transfer controller 140. Transmit poll controller 146 additionally provides at start of cell available port 200 an indication that the serial cell available signal 276 is about to begin. Signal 278 is received by transfer controller 140 at start of cell

20   available port 182. If signal 276 indicates that the device to which data is to be transferred is available, polling is halted by transmit transfer controller 140 transmitting from poll enable port 178 a signal 274 equal to "0." Such a value for signal 274, which is received by

25   poll enable port 196 on transfer poll controller 146, halts polling by transmit poll controller 146. If signal 276 indicates the device 126 to which data is to be transferred is not available, polling continues (not explicitly shown).

After polling by transmit poll controller is halted,

30   transmit transfer controller outputs an address of device 126 to which data is to be sent on address port 176. Also transmitted by transmit transfer controller 140 is a clock

signal 270 provided at clock port 174 and the data to be transferred provided at data port 170. The data signal 266, clock signal 270, and address signal 272 are received by respective ports on transmit port assembly 150 on the device 126 associated with the address indicated by signal 272.

After data transfer is initiated, transmit transfer controller 140 transmits from poll enable port 178 signal 274 equal to "1" to continue polling at step 402.

In the above-described manner, data is transferred from ATM switch 112 and received by a UTOPIA device, such as line card 114. According to the teachings of the invention, such transfer may occur over a significant link cable 122 while overcoming significant transport delay.

FIGURE 6 is a block diagram of an alternative embodiment of a communications system 410 according to the teachings of the present invention. Communications system 410 is substantially similar to communications 110, except that a parallel/serial converter 416 is included within line card 414 and a parallel/serial converter 418 is included within ATM card 411. Any suitable parallel/serial converter may be used and preferably high speed converters are used. An example converter is a Low Voltage Differential Signa (LVDS) converter. In all other respects, ATM card 411 and line card 414 are similar to ATM switch 111 and line card 114, respectively. By utilizing converters 412 and 416, the above-described data transmitted over cable 122 may be transmitted in a faster manner by converting the parallel data to serial form for transfer over cable 122 and then converting back to parallel form for use within ATM card 411 and line card 414 as described above.

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Although the present invention and its advantages have been described in detail, it should be understood that various changes, substitutions, and alterations can be made therein without departing from the spirit and scope of the present invention as defined by the appended claims.

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